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FIG. 1
PRIOR ART

DATA STORAGE SYSTEM HAVING SHARED RESOURCE
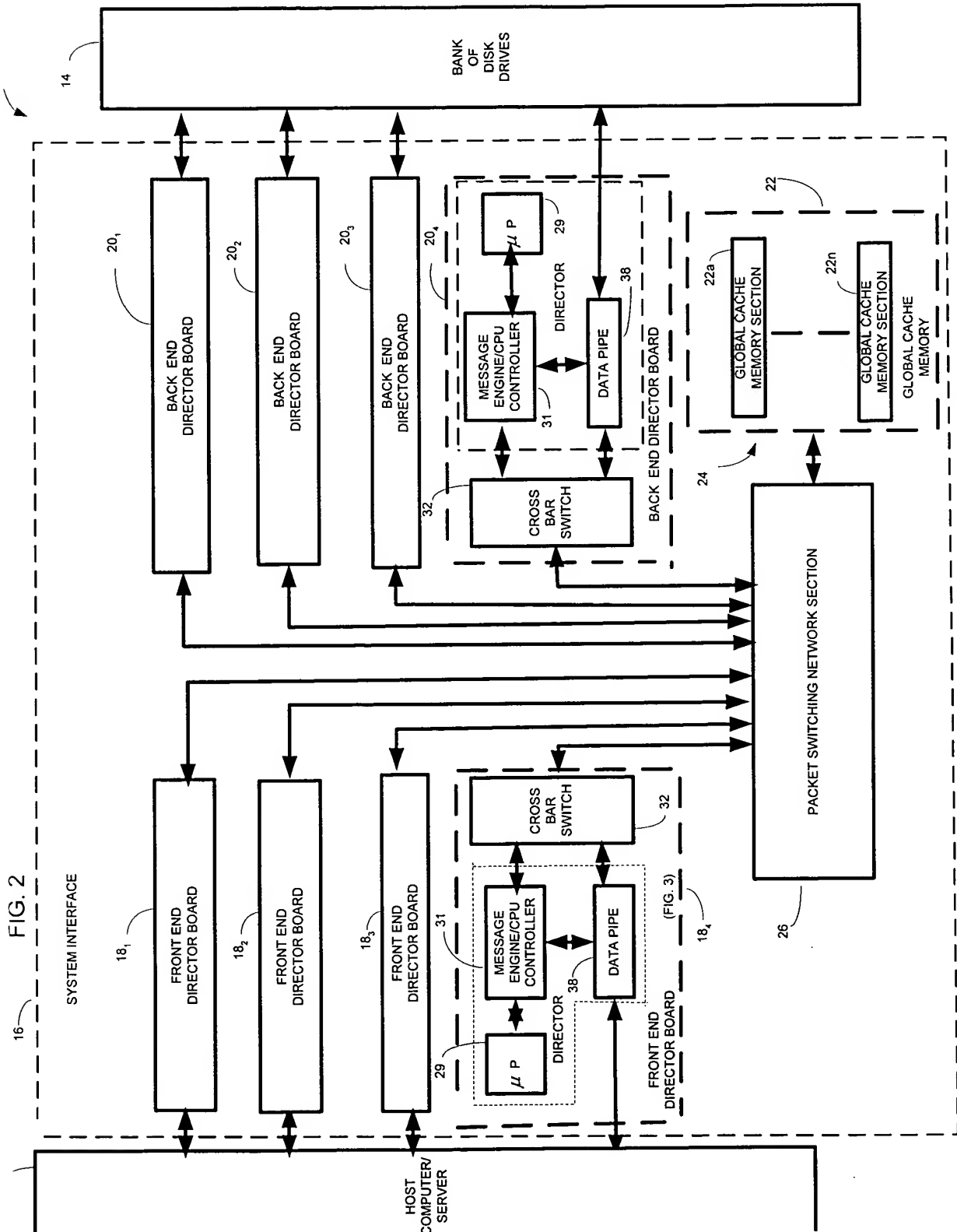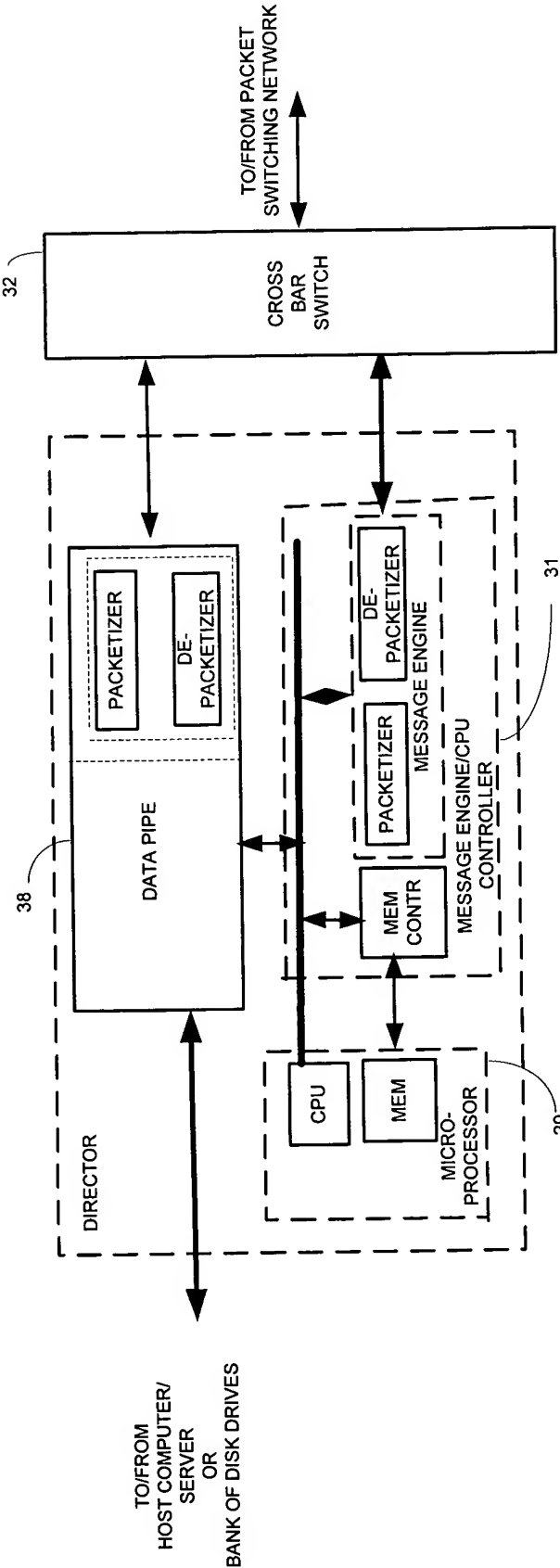John K. Walton et al.
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FIG. 2

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FIG. 3

TO/FROM PACKET SWITCHING NETWORK

CROSS BAR SWITCH

32

DIRECTOR

DATA PIPE

38

PACKETIZER

DE-PACKETIZER

DE-PACKETIZER

PACKETIZER

MESSAGE ENGINE

MESSAGE ENGINE/CPU CONTROLLER

31

MEM CONTR

CPU

MEM

MICRO-PROCESSOR

29

TO/FROM
HOST COMPUTER/
SERVER
OR
BANK OF DISK DRIVES

FIG. 2A

COMMAND | DESTINATION ID | SOURCE ID | ADDRESS | PAYLOAD | CRC

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FIG. 4

BANK OF DISK DRIVES 14
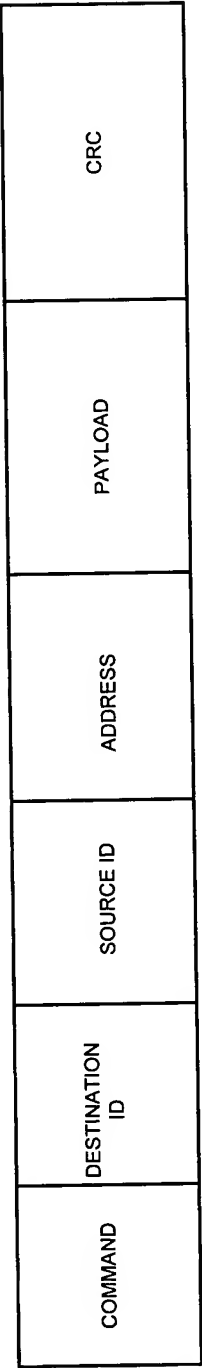
16'

BACK END DIRECTOR BOARD 20₁

BACK END DIRECTOR BOARD 20₂

BACK END DIRECTOR BOARD 20₃

μ P

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

BACK END DIRECTOR BOARD 20₄

CROSS BAR SWITCH 32

GLOBAL CACHE MEMORY SECTION

GLOBAL CACHE MEMORY SECTION

GLOBAL CACHE MEMORY 22

PACKET SWITCHING NETWORK SECTION (REDUNDANT)

26'

PACKET SWITCHING NETWORK SECTION 26

FRONT END DIRECTOR BOARD 18₁

FRONT END DIRECTOR BOARD 182

FRONT END DIRECTOR BOARD 18₃

CROSS BAR SWITCH 32

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

μ P

FRONT END DIRECTOR BOARD 18₄

HOST COMPUTER/ SERVER 12

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FIG. 5

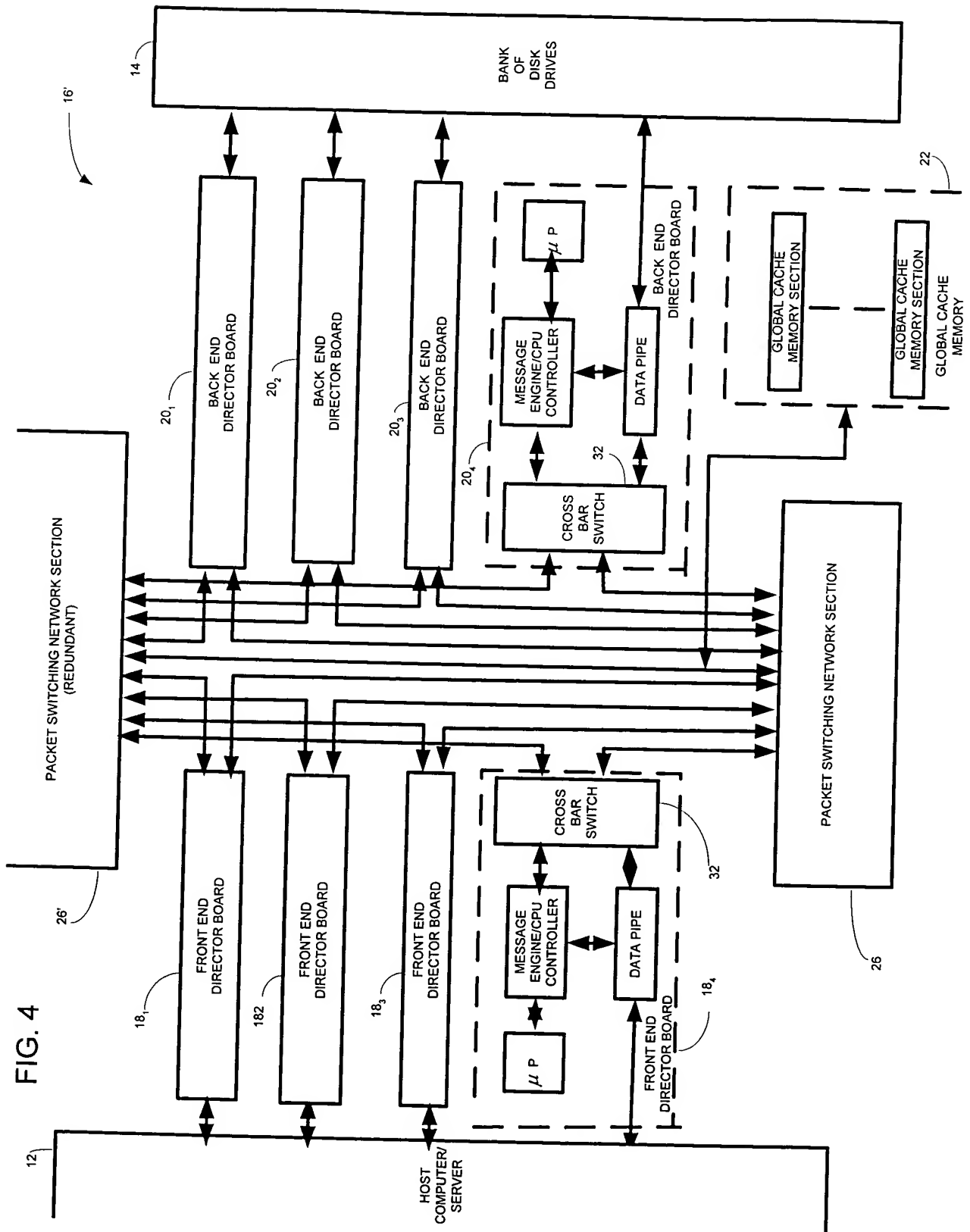BANK OF DISK DRIVES

BACK END DIRECTOR/MEMORY BOARD

BACK END DIRECTOR/MEMORY BOARD

BACK END DIRECTOR/MEMORY BOARD

DIRECTOR

µ P

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

GLOBAL CACHE MEMORY SECTION

BACK END DIRECTOR/MEMORY BOARD

CROSS BAR SWITCH

PACKET SWITCHING NETWORK SECTION

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

CROSS BAR SWITCH

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

GLOBAL CACHE MEMORY SECTION

FRONT END DIRECTOR

µ P

FRONT END DIRECTOR/MEMORY BOARD

HOST COMPUTER/ SERVER

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FIG. 6

DATA STORAGE SYSTEM HAVING SHARED RESOURCE
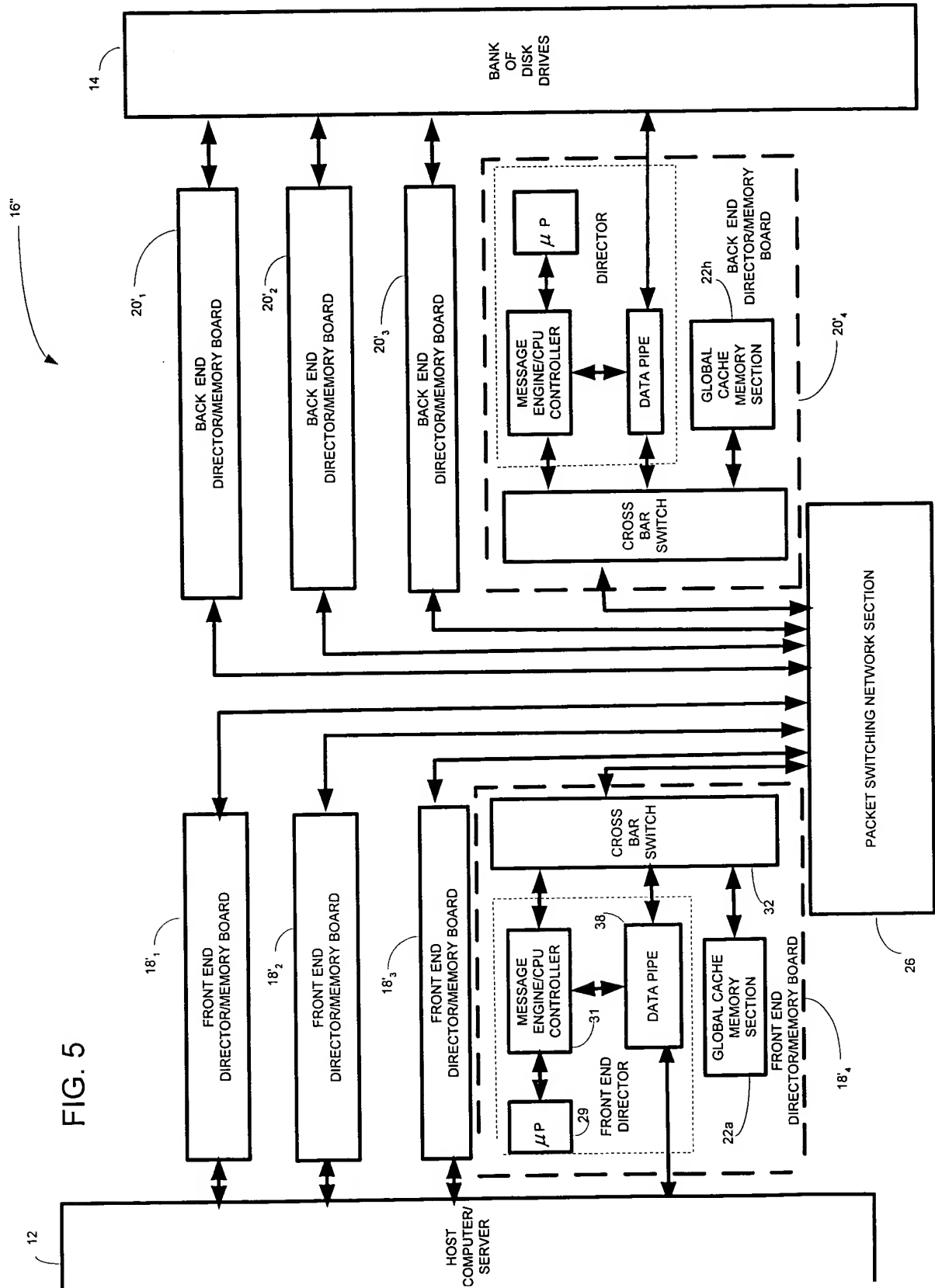John K. Walton et al.
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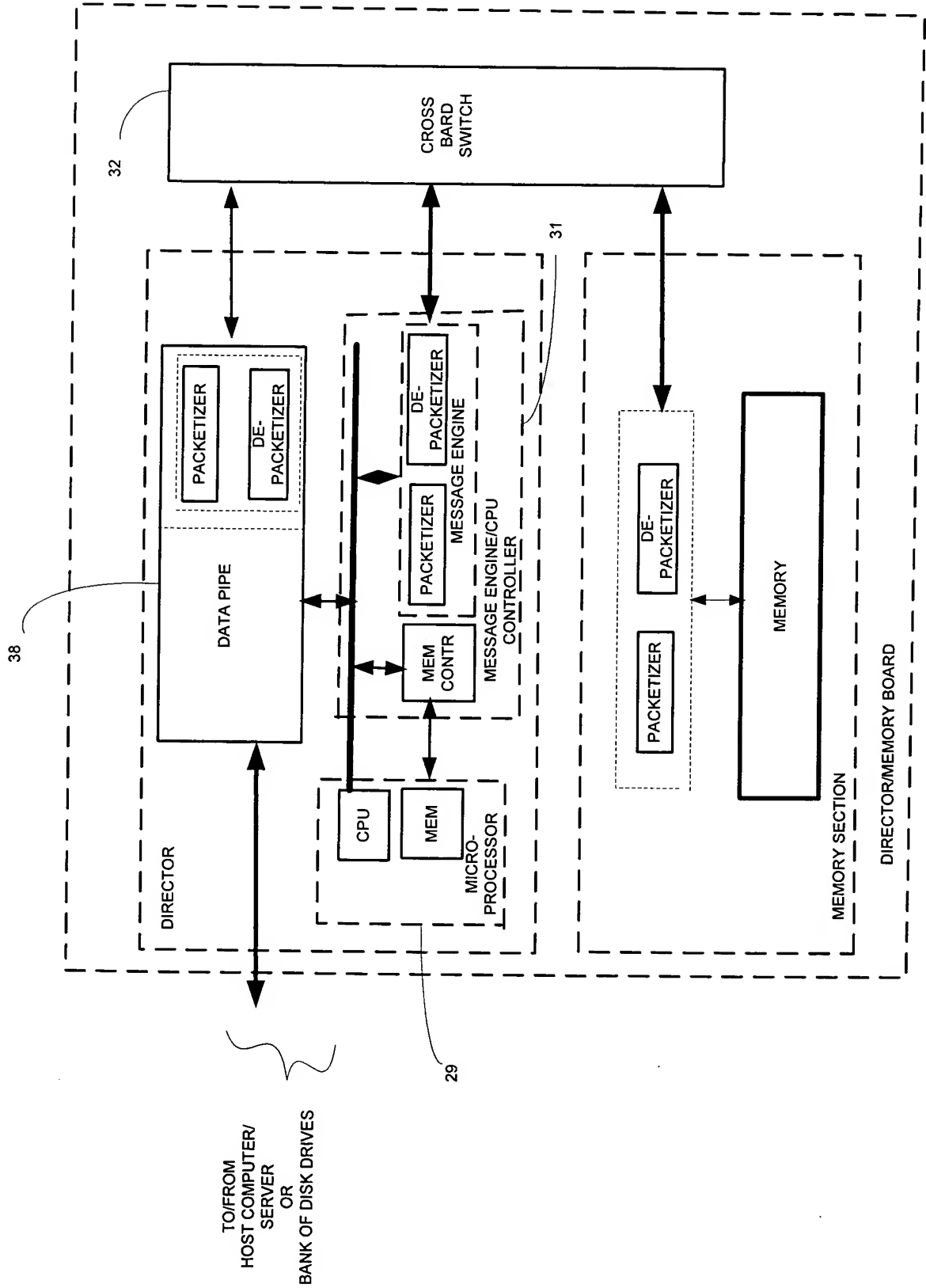
FIG. 7

BANK OF DISK DRIVES

BACK END DIRECTOR/MEMORY BOARD

BACK END DIRECTOR/MEMORY BOARD

BACK END DIRECTOR/MEMORY BOARD

μ P

DIRECTOR

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

GLOBAL CACHE MEMORY SECTION

BACK END DIRECTOR/MEMORY BOARD

CROSS BAR SWITCHING FABRIC NODE

32

32

CROSS BAR SWITCHING FABRIC NODE

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

μ P

DIRECTOR

GLOBAL CACHE MEMORY SECTION

FRONT END DIRECTOR/MEMORY BOARD

HOST COMPUTER/ SERVER

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FIG. 7A

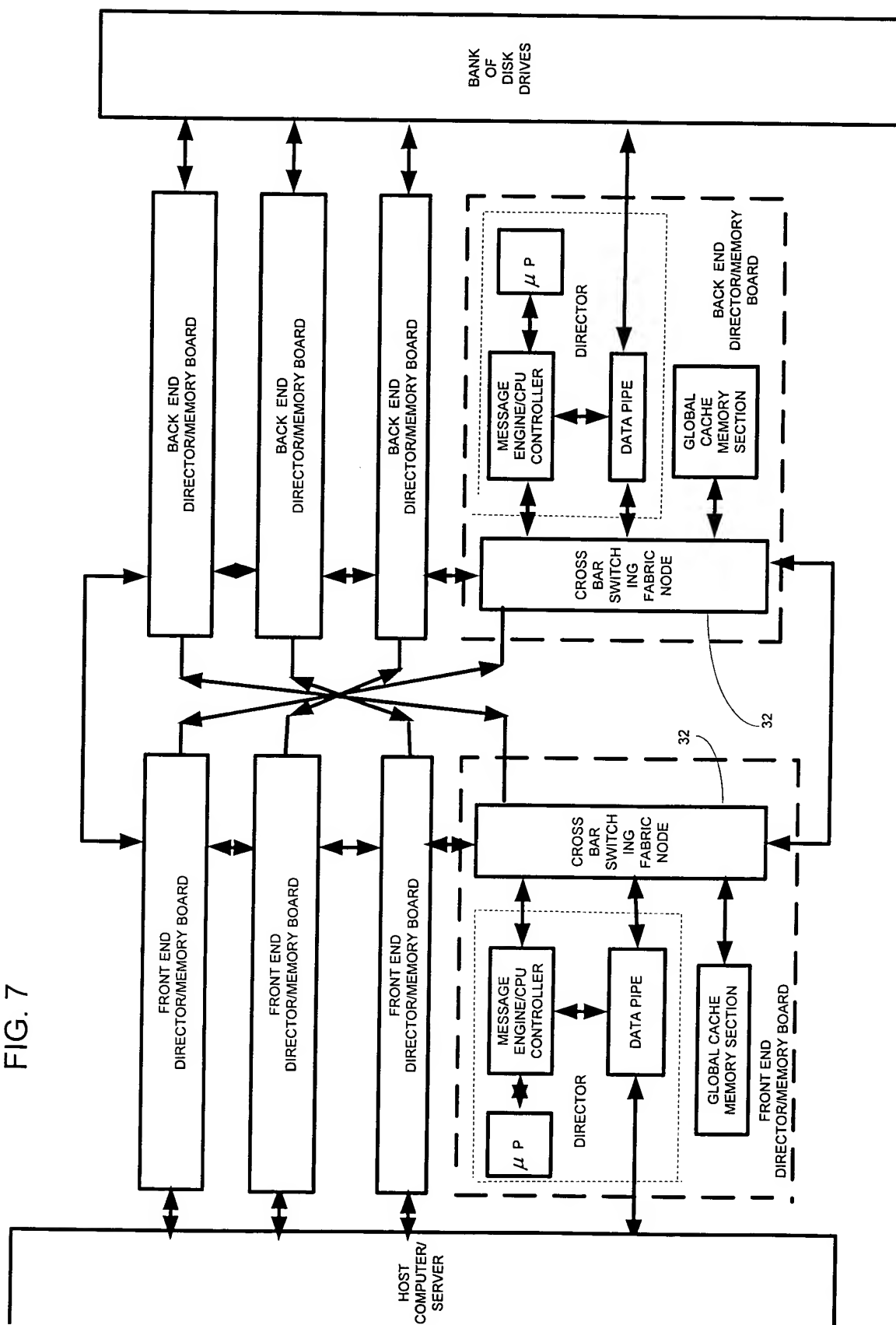DATA STORAGE SYSTEM HAVING SHARED RESOURCE
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FIG. 8

DATA STORAGE SYSTEM HAVING SHARED RESOURCE
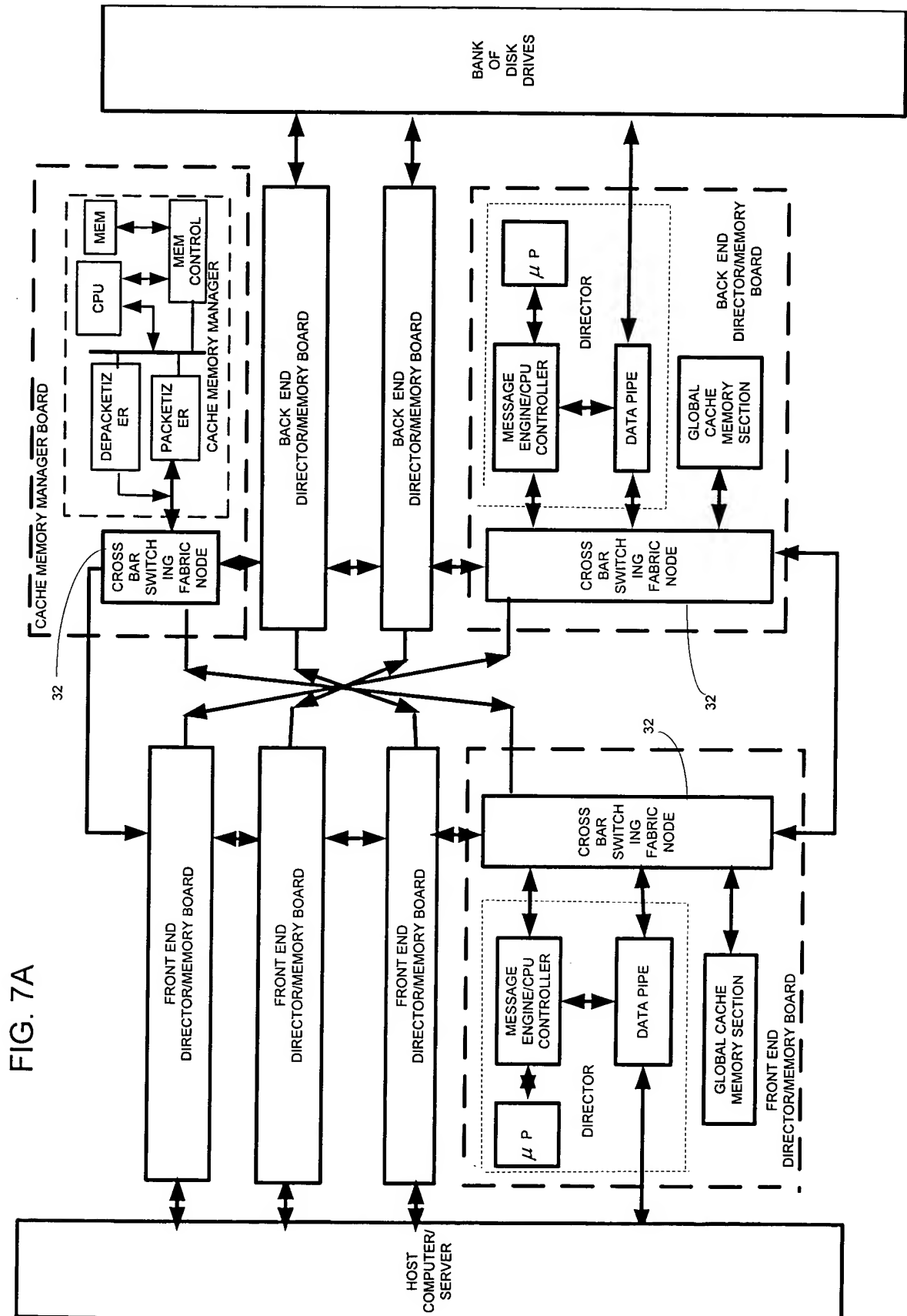John K. Walton et al.
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FIG. 9A

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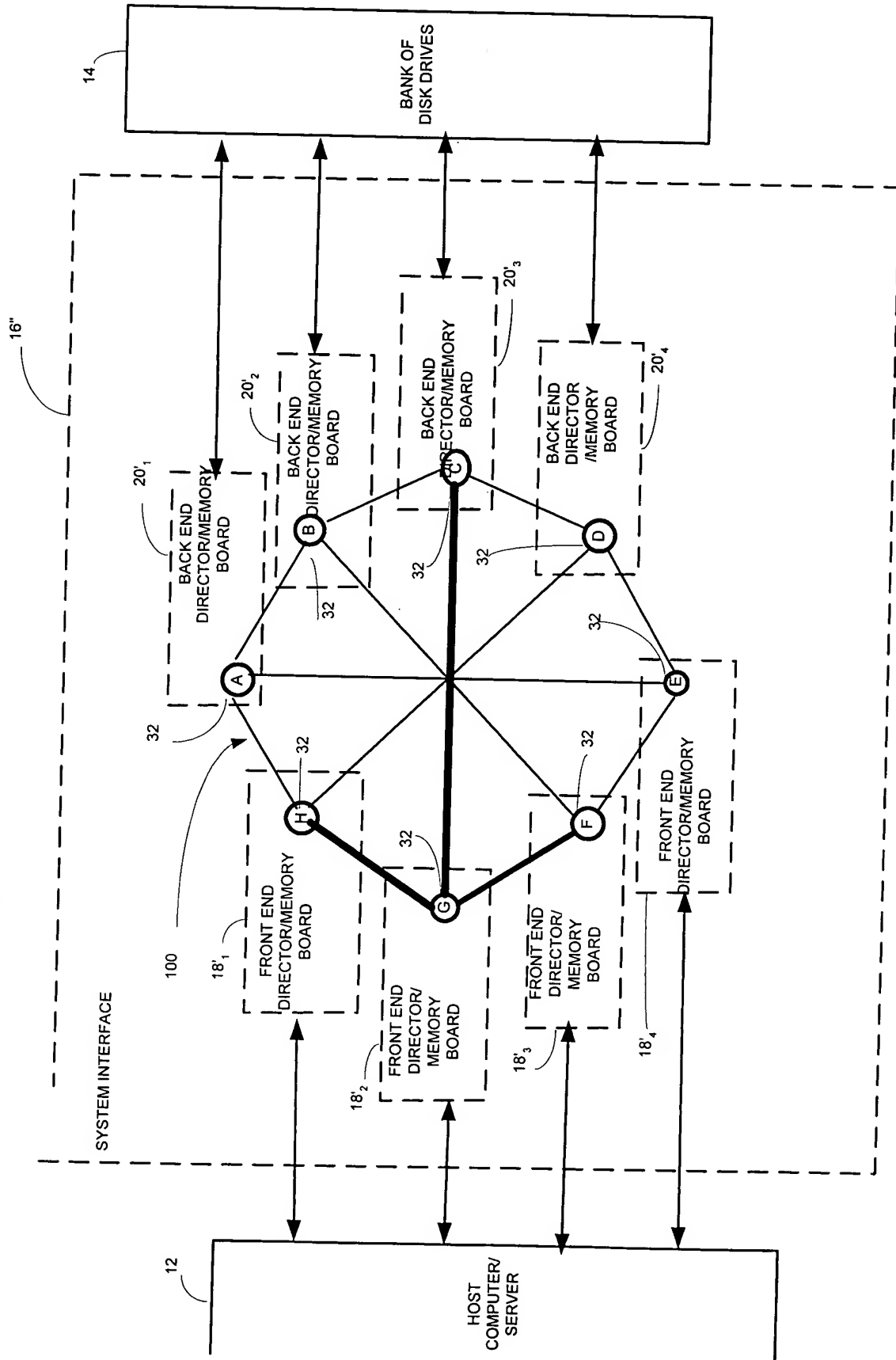EMC2-131PUS

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FIG. 9B

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FIG 9C

DATA STORAGE SYSTEM HAVING SHARED RESOURCE
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FIG. 10

BANK OF DISK DRIVES

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

BACK END DIRECTOR/MEMORY BOARD

μ P

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

DIRECTOR

GLOBAL CACHE MEMORY SECTION

BACK END DIRECTOR/MEMORY BOARD

CROSS BAR SWITCHING FABRIC NODE

32

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

FRONT END DIRECTOR/MEMORY BOARD

CROSS BAR SWITCHING FABRIC NODE

32

MESSAGE ENGINE/CPU CONTROLLER

DATA PIPE

μ P

DIRECTOR

GLOBAL CACHE MEMORY SECTION

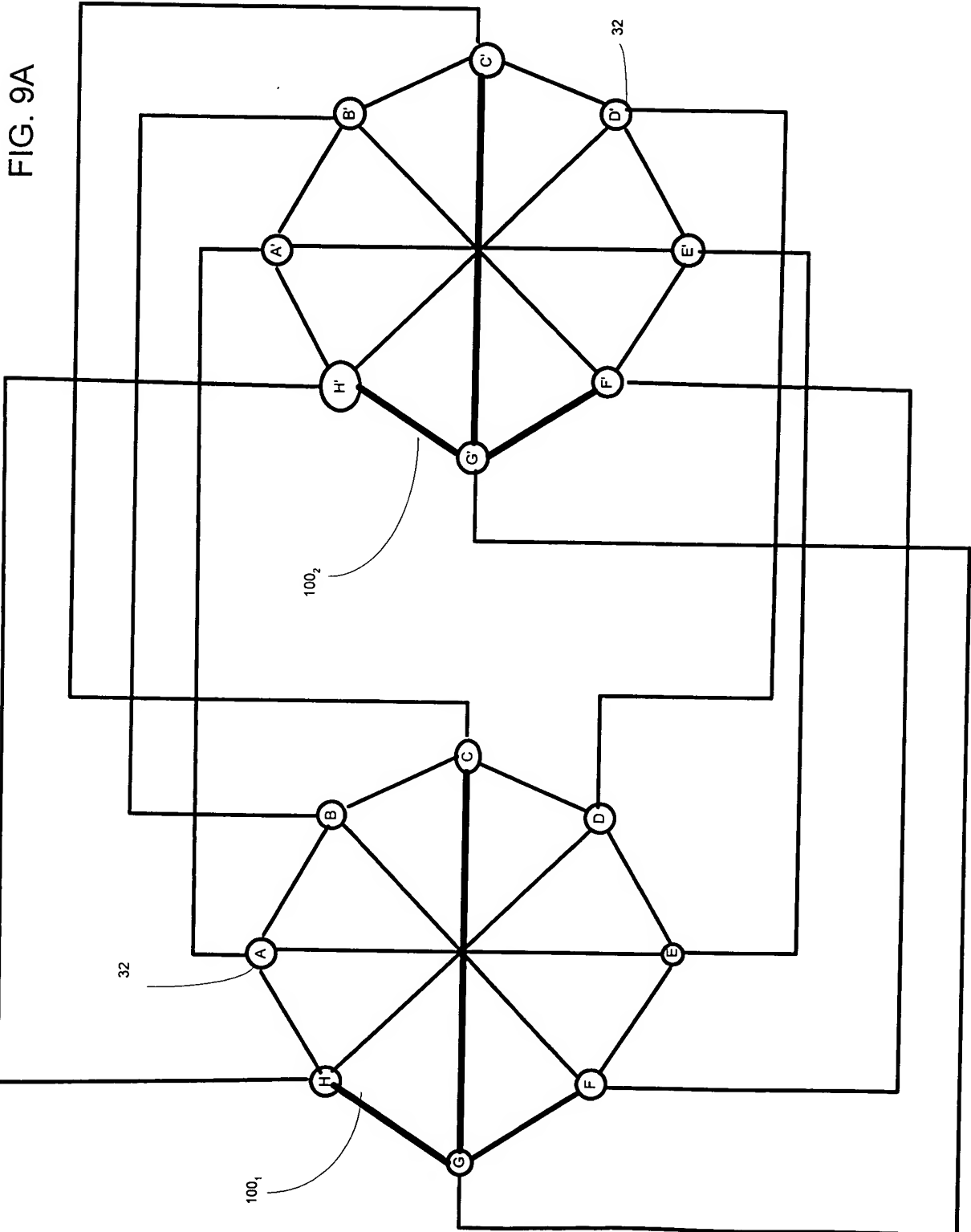FRONT END DIRECTOR/MEMORY BOARD

HOST COMPUTER/ SERVER

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FIG.11

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FIG. 12

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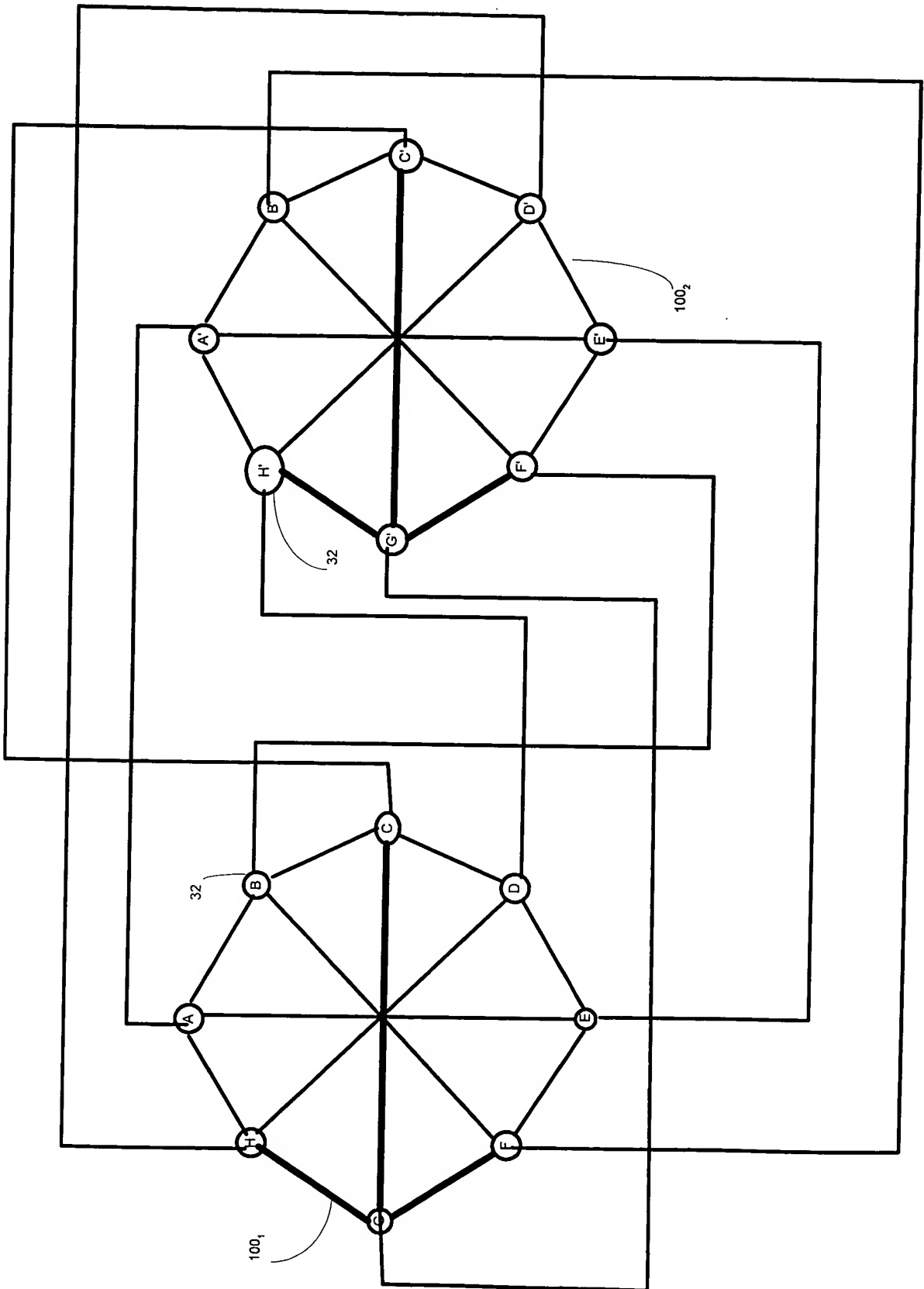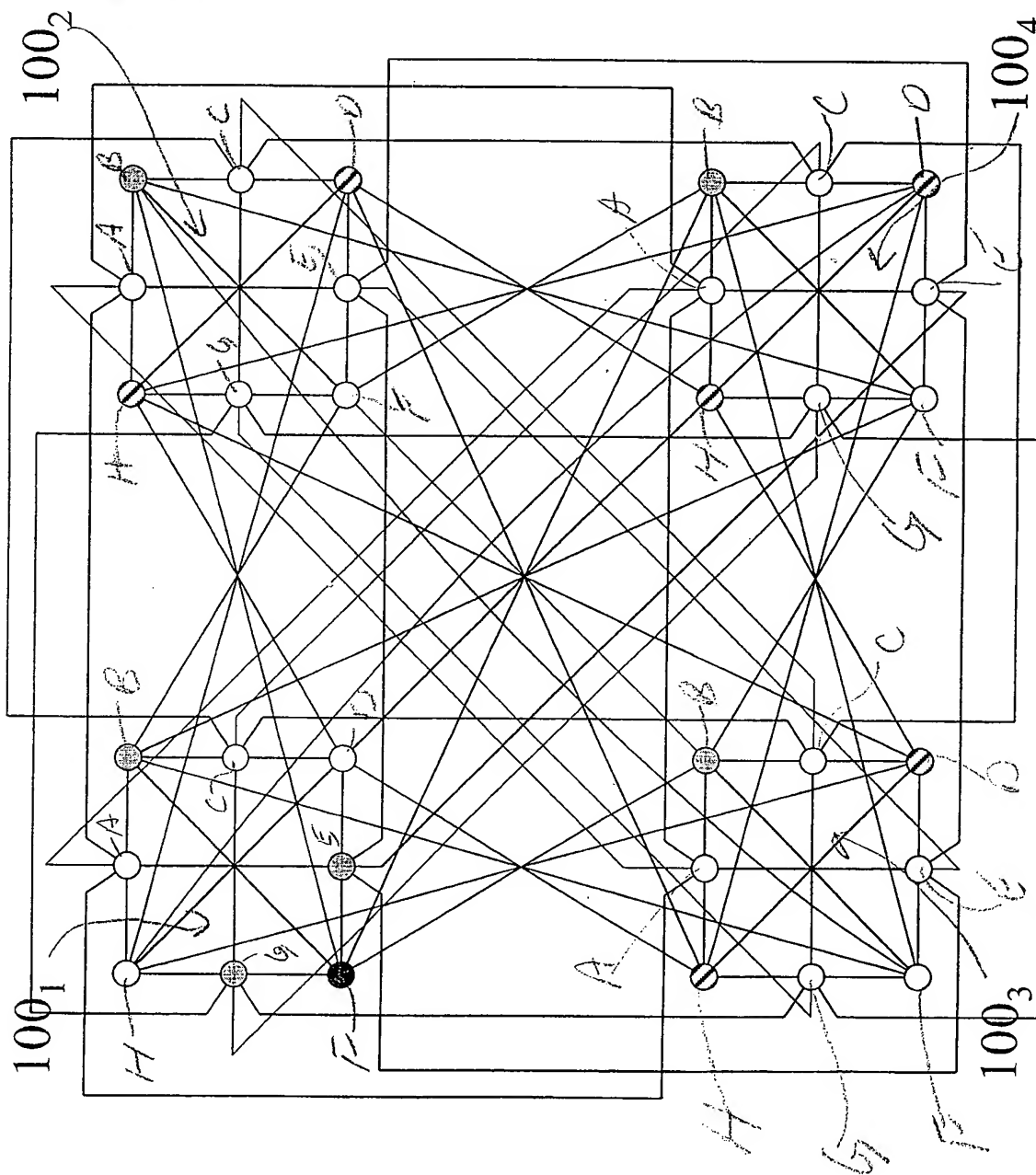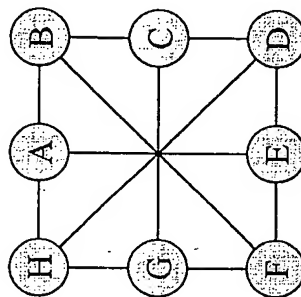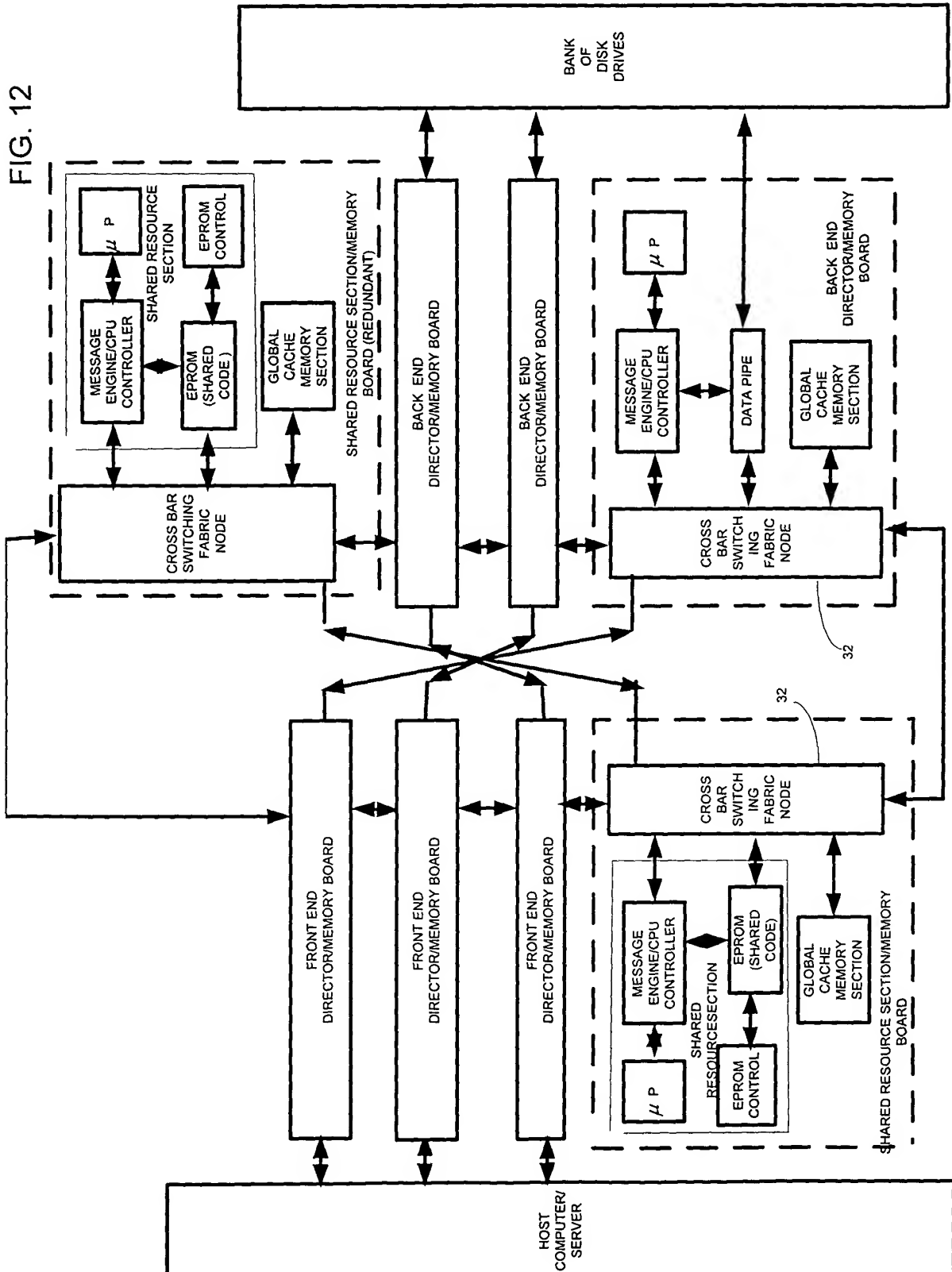
FIG. 13
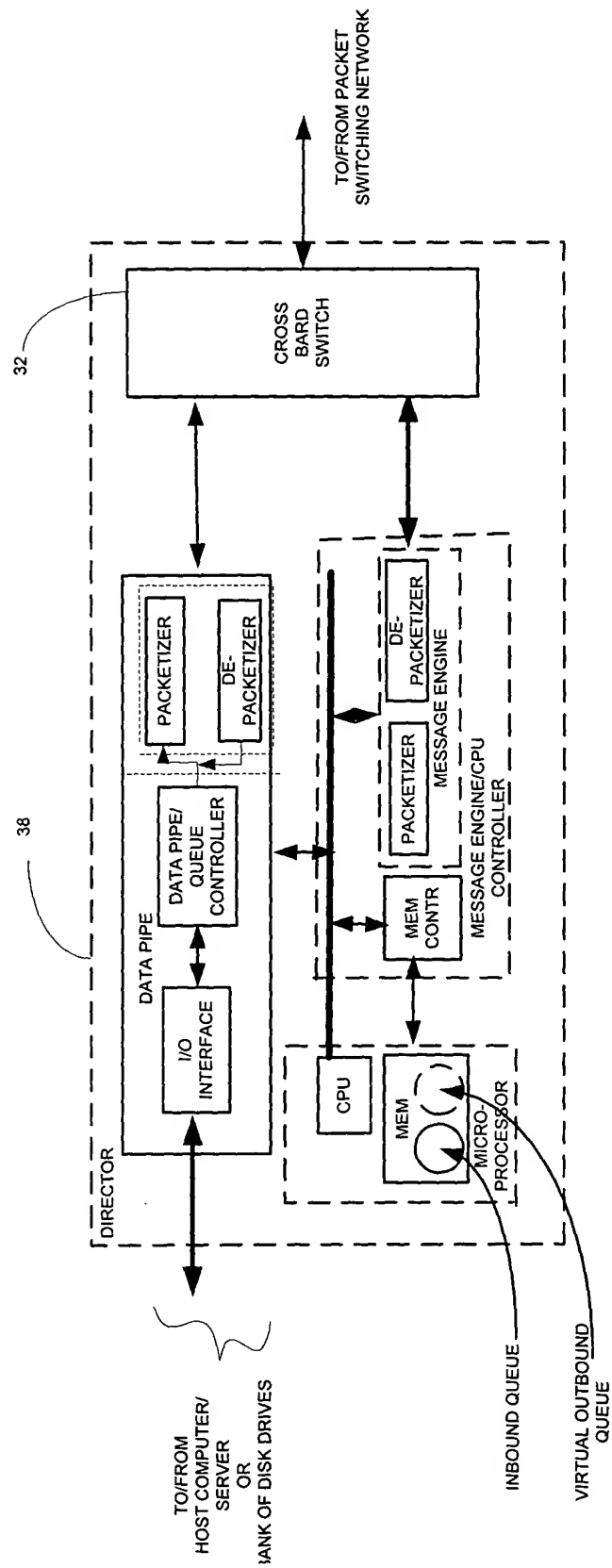
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FIG. 14
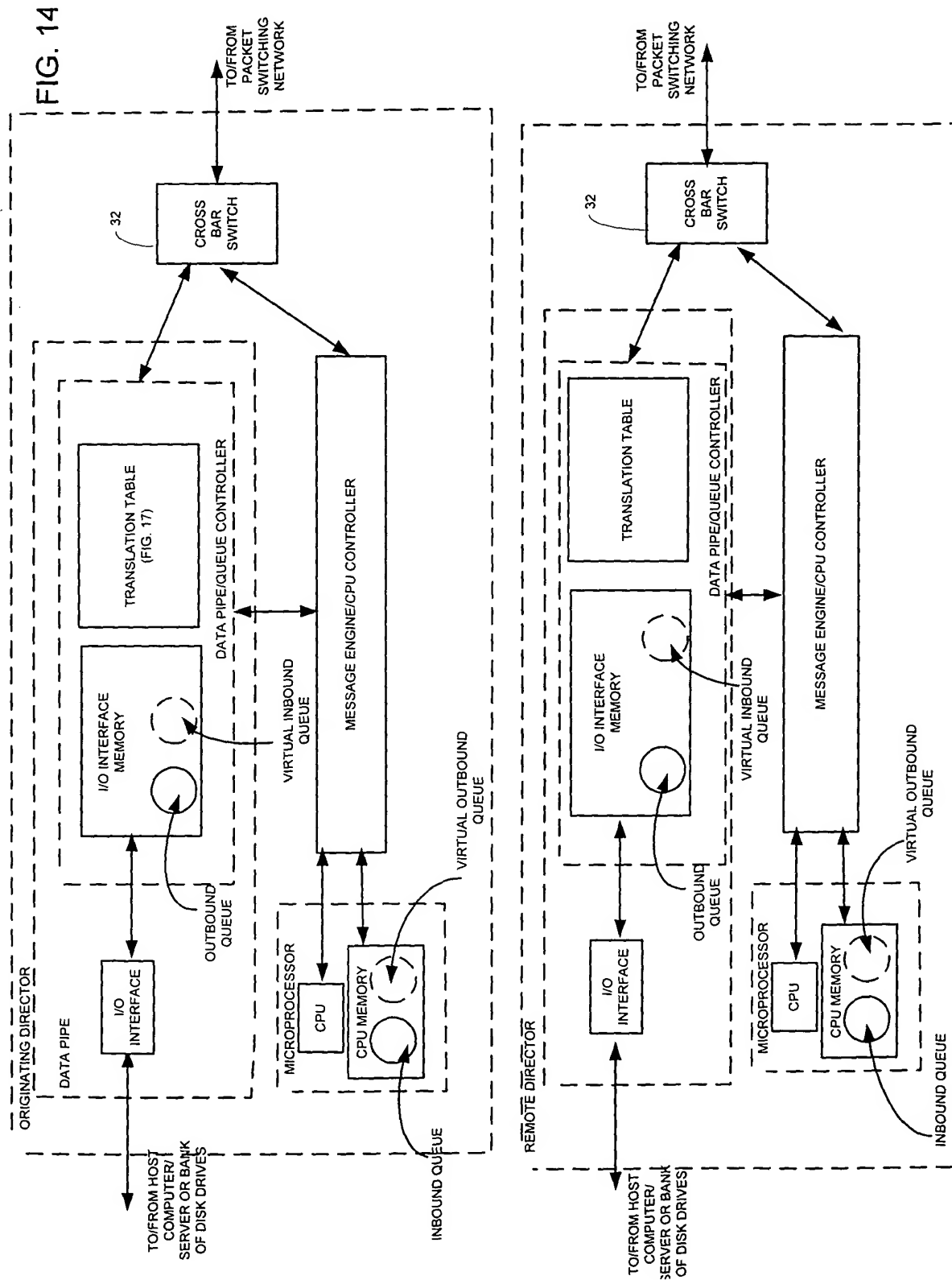
DATA STORAGE SYSTEM HAVING SHARED RESOURCE
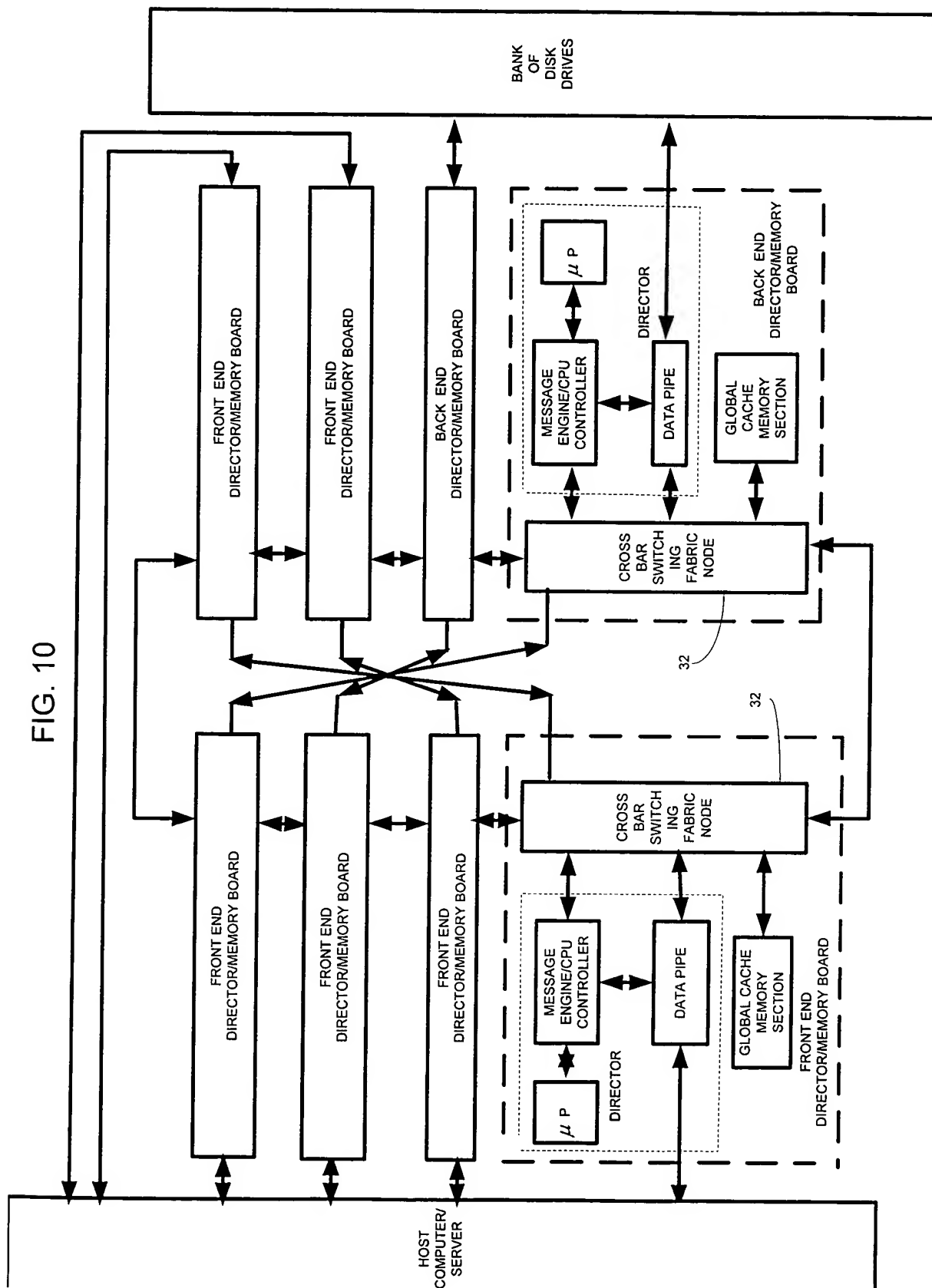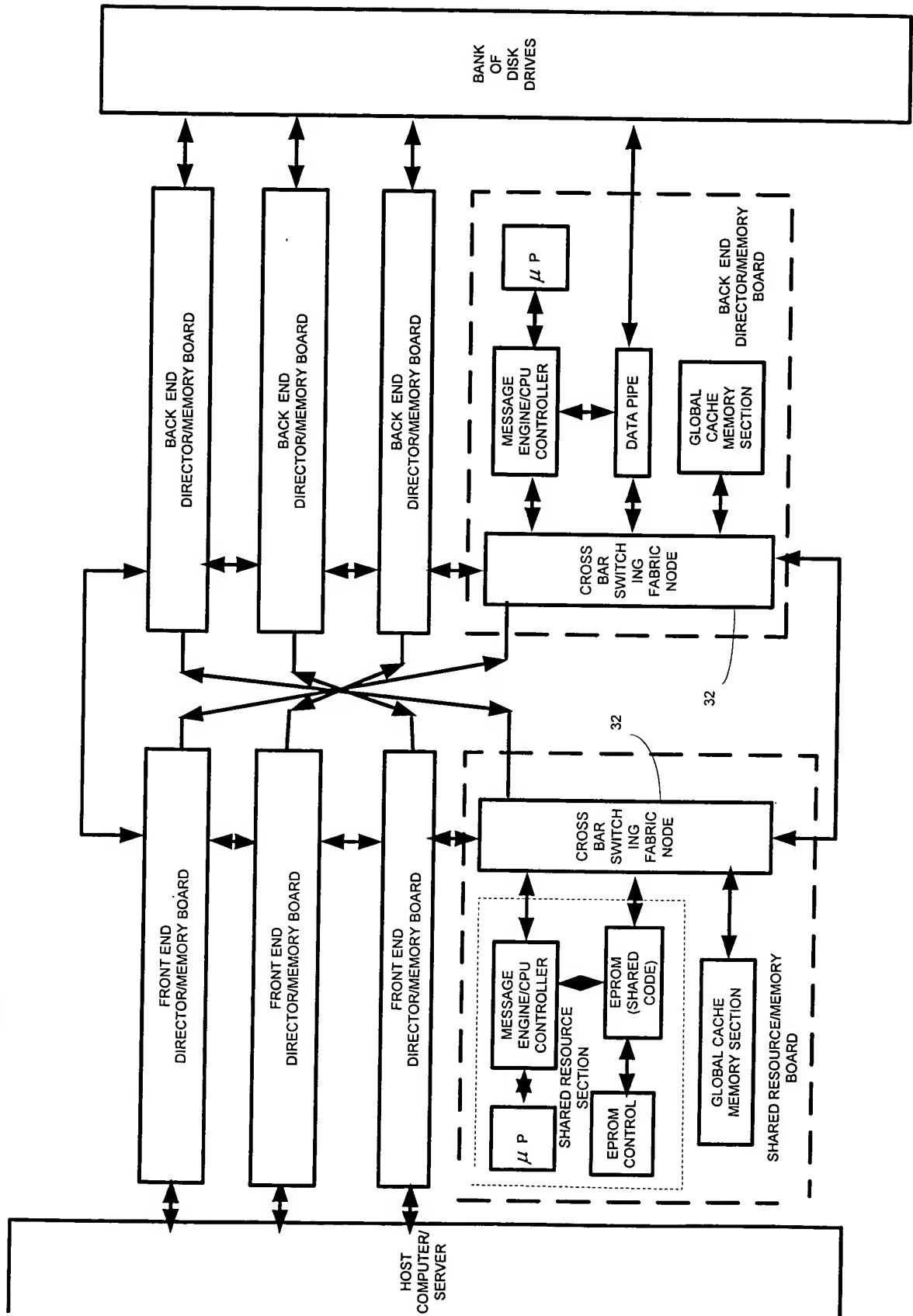John K. Walton et al.
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FIG. 15

I/O ARRIVES AT I/O INTERFACE OF ORIGINATING DIRECTOR — 1500

1502 — I/O INTERFACE OF ORIGINATING DIRECTOR CREATES A QUEUE ENTRY

1506 — THE I/O INTERFACE OF THE ORIGINATING DIRECTOR UPDATES ITS PRODUCER INDEX

1510 — THE I/O INTERFACE OF THE ORIGINATING DIRECTOR ASSERTS AN INTERRUPT REQUEST (OPTIONAL)

1504 — THE QUEUE CONTROLLER OF THE I/O INTERFACE OF THE ORIGINATING DIRECTOR TRANSLATES THE ADDRESS OF THE QUEUE ENTRY INTO AN ADDRESS FOR A REMOTE DIRECTOR USING THE TRANSLATION TABLE AND PACKETIZES THE QUEUE INFORMATION FOR TRANSMISSION ON THE PACKET SWITCHING NETWORK TO THE REMOTE DIRECTOR

1508 — THE QUEUE CONTROLLER OF THE ORIGINATING DIRECTOR TRANSLATES THE UPDATED PRODUCER INDEX USING THE TRANSLATION TABLE , PACKETIZES IT, AND THEN WRITES THE TRANSLATED PRODUCER INDEX FOR THE REMOTE DIRECTOR'S CPU INBOUND QUEUE RATHER THAN STORING IT IN THE I/O INTERFACE MEMORY

1512 — THE QUEUE CONTROLLER OF THE ORIGINATING DIRECTOR RELAYS THE INTERRUPT TO THE REMOTE DIRECTOR VIA THE PACKET SWITCHING NETWORK (OPTIONAL)

THE PACKET SWITCHING NETWORK TRANSPORTS THE WRITES AND INTERRUPT TO THE REMOTE DIRECTOR VIA THE PACKET SWITCHING NETWORK

1514

THE INTERRUPT IS RECOGNIZED BY THE REMOTE DIRECTOR OR POLLED IF NO INTERRUPT

1516

1518 — THE REMOTE DIRECTOR'S CPU READS THE INFORMATION FORMERLY WRITTEN INTO ITS CPU MEMORY POINTED TO BY THE PRODUCER INDEX SENT TO IT BY THE ORIGINATING DIRECTOR'S I/O INTERFACE

1522 — THE REMOTE DIRECTOR" S CPU UPDATES ITS CONSUMER INDEX

CPU OF THE REMOTE DIRECTOR PROCESSES THE I/O

1520

THE PACKET SWITCHING NETWORK TRANSPORTS THE UPDATED CONSUMER INDEX TO THE I/O INTERFACE OF THE ORIGINATING DIRECTOR

1524

THE INTERFACE QUEUE CONTROLLER OF THE ORIGINATING DIRECTOR RECEIVES THE CONSUMER INDEX FROM THE REMOTE DIRECTOR AND TRANSLATES THE INDEX USING THE TRANSLATION TABLE AND STORES THE TRANSLATED CONSUMER INDEX

1526

QUEUING IS COMPLETED — 1528

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1600

AN ORIGINATING DIRECTOR DECIDES TO
SEND I/O TO A REMOTE DIRECTOR

FIG. 16

1602

CPU IN THE
ORIGINATING
DIRECTOR
CREATES
QUEUE ENTRY

1604

THE CPU IN THE ORIGINATING DIRECTOR UPDATES
ITS PRODUCER INDEX FOR TRANSMISSION VIA THE
PACKET SWITCHING NETWORK RATHER THAN
STORING IT IN ITS OWN CPU MEMORY

1608

1606

PACKET SWITCHING NETWORK TRANSPORTS WRITES TO REMOTE DIRECTOR'S I/O INTERFACE

THE QUEUE CONTROLLER OF THE
REMOTE DIRECTOR'S I/O
INTERFACE TRANSLATES THE
ADDRESS RECEIVED FROM THE
ORIGINATING DIRECTOR INTO AN
ADDRESS IN THE OUTBOUND
QUEUE USING ITS OWN
PRODUCER INDEX

THE QUEUE CONTROLLER OF THE
REMOTE DIRECTOR'S I/O INTERFACE
UPDATES ITS OWN PRODUCER INDEX
AND STORES IT WHERE EXPECTED BY
SUCH I/O INTERFACE

1610

1612

THE REMOTE DIRECTOR'S I/O INTERFACE
RECOGNIZES THE INDEX UPDATE, READS
THE QUEUE AND UPDATES ITS CONSUMER
INDEX

1616

1616

THE QUEUE CONTROLLER OF THE REMOTE DIRECTOR SEES THE CONSUMER INDEX
UPDATE, TRANSLATES IT TO THE CONSUMER INDEX FOR THE ⊡REMOTE NODE USING THE
TRANSLATION TABLE, AND TRANSMITS IT OVER THE PACKET SWITCHING NETWORK TO
THE ORIGINATING DIRECTOR

1614

I/O INTERFACE
PERFORMS
ACTION
REQUESTED

PACKET SWITCHING NETWORK TRANSPORTS WRITES TO ORIGINATING DIRECTOR'S I/O INTERFACE

1618

CONSUMER INDEX IS UPDATED IN THE REMOTE NODE (USED FOR OVERFLOW CHECKING)

1618

QUEUING IS
COMPLETED

1622

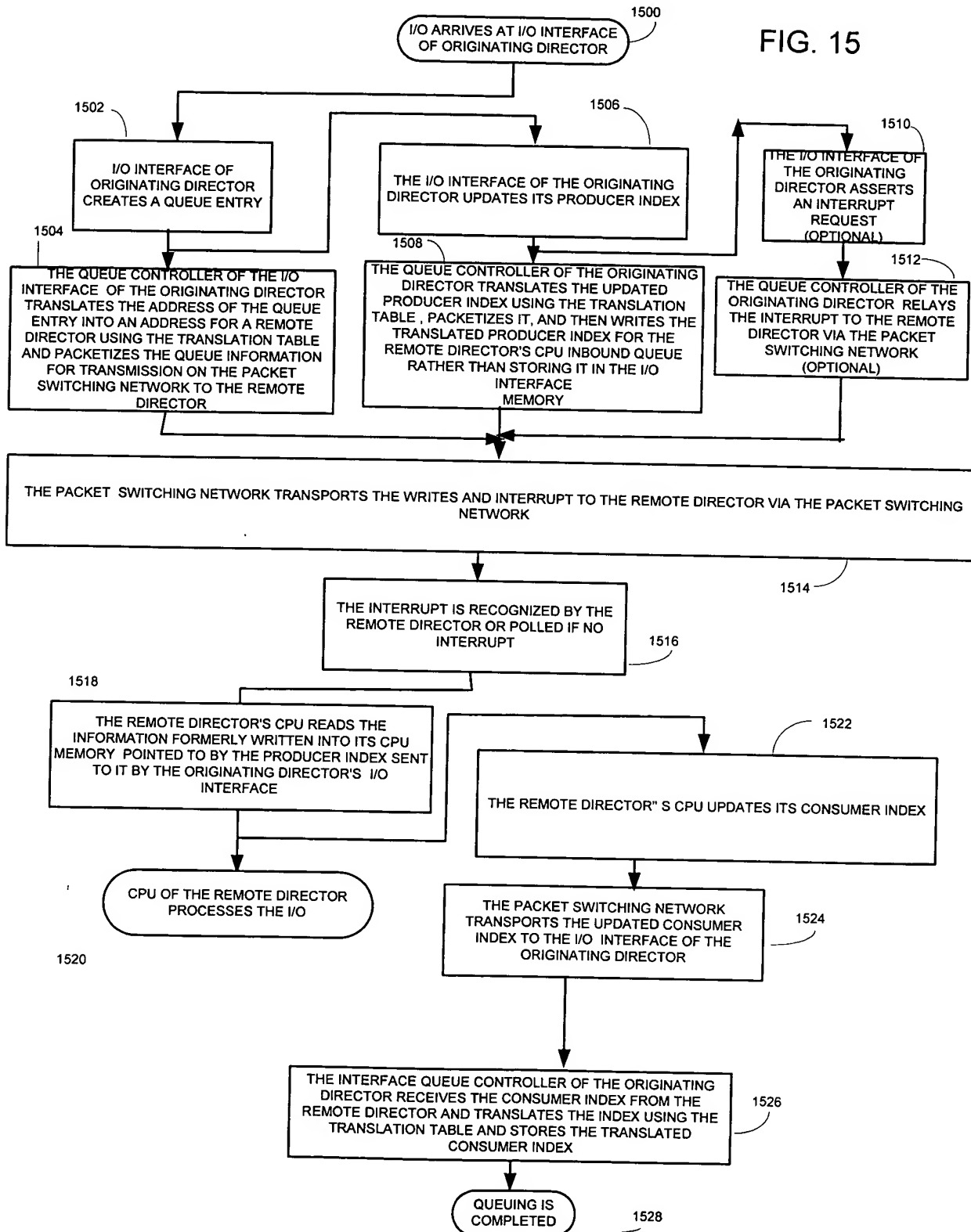DATA STORAGE SYSTEM HAVING SHARED RESOURCE
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Translation Table Format

FIG. 17

Address

Data

$f(x)$ →

Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info
Remote CPU Number	Remote Producer Index	Remote Consumer Index	Misc. Remote Info